REMARKS

Claims 1-20 are pending in the present applications, and have been examined. The examiner maintains his rejection of claims 1-20. Applicants address the present actions as follows.

Claims 1-20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Bhat et al. (U.S. Pat. No. 5,207,864) in view of Cohn et al. (U.S. Pat. No. 7,276,789). Applicants traverse this rejection.

The examiner asserts that Cohn is cited to demonstrate that hot isostatic pressing is functionally equivalent to the uniaxial pressure application disclosed in Bhat as a means of applying heat and pressure. However, this assertion is incorrect. Cohn merely teaches that hot isostatic pressing is a technique that can be used to bond metallic bonding features to metallic target features. Moreover, the sole reference to hot isostatic pressing in Cohn states that "[s]till another alternative for supplying the necessary pressure and heat is to place a substrate pair into a high-temperature bag (made of a material as polyimide or metal foil) and subject it to hot-isostatic pressing." It is clear from this statement that Cohn suggests traditional hot isostatic pressing with vacuum encapsulation of wafers in a bag while embodiments of the present invention propose hot isostatic pressing of wafers without encapsulation in such a container. This is a crucial difference because semiconducting wafers, unlike metal wafers, are very sensitive to contamination which is likely to occur during a contact between the wafers and a material of the bag, especially under conditions of high pressure and temperature. In embodiments of the present invention, pressure is supplied by argon gas or by other gas

directly to semiconducting wafers without contaminating the wafers with impurities. Additionally, Cohn's method necessarily requires an additional step of releasing the wafers from the encapsulating bag after the hot isostatic pressing. This releasing step is impractical in embodiments of the present invention due to the fragile nature of semiconducting wafers (See paragraph 4 of the concurrently-filed § 132 declaration).

Applicants also disagree with the examiner's assertion that hot isostatic pressing is functionally equivalent to the uniaxial pressure application disclosed in Bhat as a means of applying heat and pressure because, as stated in paragraph 16 of the § 132 declaration filed herewith, isostatic pressing is fundamentally different than uniaxial pressure application. That is, the different methods of pressure application cause different stress fields. Specifically, in uniaxial pressing the difference in stresses in the axial (i.e., the direction of force application in uniaxial pressing) and radial directions generates a shear stress which may result in wafer fraction under high uniaxial pressures.

Applicants also disagree with the examiner's assertion because Cohn is silent regarding the application of hot isostatic pressing to semiconductor wafers, which react differently to heat and pressure and have different bonding conditions than the metallic bonding features and target features disclosed in Cohn, as stated in paragraph 4 of the § 132 declaration filed herewith.

The examiner also cites Curbishley et al. (U.S. Pat. No. 4,587,700), Boys (U.S. Pat. No. 5,215,639), Macris (U.S. Pub. No. 2002/0069906), Zhang (U.S. Pat. No. 6,521,108), Oda et al. (U.S. Pub. No. 2003/0134143), Takahashi et al. (U.S. Pat. No. 6,793,124), Koenigsmann et al. (U.S. Pub. No. 2005/0115045), Stark (U.S. Pat. No.

6,962,834, hereinafter, "Stark '834"), Stark (U.S. Pub. No. 2005/0257877, hereinafter "Stark '877"), and Yi et al. (U.S. Pub. No. 2009/0078570) to disclose the functional equivalence of hot isostatic pressing. However, none of these references discloses that hot isostatic pressing is functionally equivalent to applying heat and uniaxial pressure to bond semiconductor wafers.

As stated in paragraph 5 of the § 132 declaration filed herewith, Curbishley discloses that hot isostatic pressure is used to form a diffusion bond between a hollow cylinder and a hub (see col. 4, lns. 26-29). The hollow cylinder is formed from a nickel-based superalloy such as MAR-M247 (col. 3, lns. 44-47). The hub is composed of a preconsolidated powder metal low carbon Astroloy, a fine-grained superalloy material (col. 3, lns. 66-68). Thus, Curbishley merely discloses that hot isostatic pressing can be used to form diffusion bonds in metal.

As stated in paragraph 6 of the concurrently-filed § 132 declaration, Boys teaches that hot isostatic pressing can be used to bond a target and a backing plate (see col. 6, lns. 50-57). While Boys fails to disclose a material for use as the target material, the reference teaches that the backing plate is formed of copper or aluminum (col. 6, lns. 8-10). Alternatively, Boys teaches that the backing plate and target may be a refractory metal with low plasticity, and an interstitial material such as copper or aluminum may be interposed between the backing plate and the target (col. 8, lns. 17-21). Thus, Boys discloses only that hot isostatic pressing can be used to bond metals.

Macris discloses that hot isostatic pressing is a known technique for metallurgical bonding (paragraph [0013]), and for sintering related to bismuth, tellurium,

selenium, and antimony thermoelements (paragraph [0027]), as stated in paragraph 7 of the § 132 declaration. Macris further discloses the use of hot isostatic pressing to increase the density of thermoelements on wafers (see paragraph [0073]; [0075]). Each wafer is composed of a metallic or semi-metallic material (paragraph [0061]). Accordingly, Macris merely describes metal bonding.

As stated in paragraph 8 of the § 132 declaration filed herewith, Zhang teaches diffusion bonding of targets made from copper and cobalt, or alloys thereof with backing plate members made of an aluminum alloy (See col. 2, lns. 59-61; col. 3, lns. 9-10). Additionally, Zhang teaches that an interlayer formed from silver or a silver alloy (or other IB elements such as gold and alloys thereof, or VIII elements such as palladium, platinum, and their alloys) is used between the target and the backing plate (col. 2, line 66 - col. 3, line 3). That is, Zhang merely teaches diffusion bonding of metal bonding targets, a metal backing plate, and a metal interlayer.

Oda discloses diffusion bonding between a tantalum or tungsten target and a copper alloy backing plate (see abstract, paragraph [0022]). Oda also teaches that an aluminum insert layer is interposed between the target and the backing layer (paragraph [0018], [0030], [0034]). Further, sheets of nickel and silver may be used as additional insert layers (paragraph [0034]). Thus, Oda merely describes diffusion bonding of metal components. This information is stated in paragraph 9 of the § 132 declaration filed concurrently with this response.

Takahashi teaches that a high-purity cobalt target is bonded to a copper alloy backing plate (see abastract, col. 2, lns. 58-59). Additionally, Takahashi teaches

that an aluminum or aluminum alloy insert layer is placed between the target and the backing plate (abstract, col. 2, lns. 63-65). Thus, Takahashi discloses a method of bonding metals, as stated in paragraph 10 of the § 132 declaration filed with this response.

As stated in paragraph 11 of the concurrently-filed § 132 declaration, Koenigsmann teaches forming a sputter target from a ferromagnetic material, such as nickel, iron, cobalt or alloys thereof (see Koenigsmann, paragraph [0031]). A backing plate is formed from any number of metals, including aluminum, titanium, copper, and alloys thereof (paragraph [0034]). Also, a bond metal layer made from gold, silver, platinum, palladium, iridium, rhodium, ruthenium, or osmium may be applied between the sputter target and the backing layer (paragraph [0037]). Koenigsmann discloses that hot isostatic pressing is an advantageous method of forming solid state bonds between these components. Thus, Koeniggsmann only teaches that hot isostatic pressing is used to bond metals.

Stark '834 teaches that a frame and a sheet are joined using hot isostatic pressing to form a hermetic seal circumscribing a window region (col. 19, lns. 33-37). The frame is a Kovar alloy/nickel/gold frame, and the sheet is a metalized sheet having aluminum as a final layer (col. 19, lns. 58-62). That is, Stark '834 only describes joining a metal frame to a metalized sheet. This information is stated in paragraph 12 of the § 132 declaration filed herewith.

Stark '877 discloses that diffusion bonding can be used to join a first layer, a second layer, and a substrate (see paragraph [0046]). The first layer is formed from an

electrical conductor, a semiconductor, or an electrical insulator. The second layer is formed from an electrical insulator, and the substrate is formed from a semiconductor material (see abstract). Accordingly, Stark '877 fails to disclose that two semiconductor materials are bonded without an interlayer using hot isostatic pressing, as stated in paragraph 13 of the § 132 declaration filed with this response.

Yi teaches that a target and a backing layer are joined together via an interlayer. The target can comprise one or more of titanium, tantalum, zirconium, hafnium, niobium, vanadium, tungsten, copper, or a combination thereof. The interlayer can be formed of one or more of silver, copper, nickel, tin, titanium, and indium. The backing plate includes at least about 0.1 weight percent (%) of each of copper, chromium, nickel and silicon (see paragraph [0017]). Thus, Yi merely teaches joining metallic layers, and not semiconductor layers, as stated in paragraph 14 of the concurrently-filed § 132 declaration.

Thus, after reviewing each of the references cited by the examiner, none of the references discloses that hot isostatic pressing can be used to join two semiconductor wafers without their vacuum encapsulation in a bag. In contrast, as stated in paragraph 15 of the § 132 declaration, Bhat discloses fusing two semiconductor wafers by applying heat and uniaxial pressure to the wafers (See Bhat col. 3, lns. 43-52). Accordingly, applicants assert that the hot isostatic pressing described in the above references is not functionally equivalent to the uniaxial pressing disclosed in Bhat for bonding of semiconductor wafers, since techniques used to form diffusion bonds in metals are not directly applicable to fusion of semiconductor wafers, as recited in paragraph 16 of the §

132 declaration. Since the hot isostatic pressing processes described in the cited references are not functionally equivalent to the uniaxial pressing disclosed in Bhat, one of ordinary skill would not have been motivated to alter the process disclosed in Bhat based on the teachings of Cohn. For this reason, applicants respectfully request withdrawal of the rejection of claims 1-20.

Additionally, the bonding process disclosed in Bhat produces a different bond than the process described in Cohn. That is, the bonding process described in Bhat teaches that semiconductor wafers are heated while applying uniaxial bonding pressure using a weighted block. The thermocompressive process causes uniform fusion throughout the wafer hetero-interface, with the exception of small dislocations caused by lattice mismatch (col. 4, lns. 15-20). Thus, Bhat teaches that heat and uniaxial pressure should be used to directly bond semiconductor wafers through chemical fusion, forming covalent bonds between the wafers (see col. 4, lns. 57-64; col. 6, lns. 12-16).

In contrast, Cohn teaches that metallic bonding features disposed on an upper surface of a first substrate are aligned with corresponding metallic target features disposed on a lower surface of a second substrate (col. 7, lns. 32-34; col. 8, lns. 1-6). The bonding features initially have a height of at least three microns, but during the bonding process heat and pressure are applied until the bonding have been deformed or compressed by roughly 50% (col. 7, lns. 53-54; col. 8, lns. 38-40). That is, after the bonding process described in Cohn, the wafers are separated from one another by a distance of about 1.5 microns. Thus, while the wafer fusion process disclosed in Bhat produces covalent bonds between fused wafers, the substrates disclosed in Cohn are not

even directly in contact with each other after the bonding process. Further, while the entire surface of the wafer hetero-interface disclosed by Bhat is fused, the process disclosed by Cohn merely describes that bonds are formed at areas where bonding and target features overlap. For these additional reasons, applicants again assert that one of ordinary skill in the art would not combine wafer fusion process disclosed by Bhat with the hot isostatic pressing disclosed in the bonding process of Cohn. For these additional reasons, applicants again request withdrawal of the rejection of claims 1-20.

Moreover, the examiner asserts that it would be obvious to try substituting the bonding method of Cohn for the one disclosed in Bhat because it was one of "a finite number of identified, predictable solutions" (see p. 4, lns. 12-14 of the outstanding office action). However, the "obvious to try" rationale identified by the examiner also requires a reasonable expectation of success (see MPEP §§ 2143.02; 2145(X)(B)). As discussed above, Cohn merely teaches that hot isostatic pressing can be used to bond metallic features. There is nothing in Cohn or any of the other cited references that suggests that hot isostatic pressing of wafers without vacuum encapsulation in a bag would be successful in bonding semiconductor wafers. Moreover, the isostatic pressing of Cohn is fundamentally different than uniaxial pressure application disclosed in Bhat because of different stress fields caused by the different pressure application techniques.

Further, as stated in paragraph 17 of the § 132 declaration filed herewith, those of skill in the art did not believe that hot isostatic pressing, particularly without inhibition of pressure penetration between semiconductor wafers, would successfully result in stronger bonding between the wafers. It was not even known that fragile

semiconducting wafers would be able to survive application of 200 MPa isostatic pressure, which corresponds to 40516 kgf for a 2 inch diameter wafer. Thus applicants assert that a person having ordinary skill in the art would not have had a reasonable expectation of success in attempting to combine the methods disclosed in Bhat and Cohn. For these reasons, withdrawal of the rejection of claims 1-20 is again requested.

For all the foregoing reasons, applicants submit that this application is in condition for allowance, which is respectfully requested. The examiner is invited to contact the undersigned attorney is an interview would expedite prosecution.

Respectfully submitted,

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